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14. ABSTRACT
An international workshop titled, **Role of the Bay of Bengal for Prediction of the Indian Monsoon**, was organized at the Woods Hole Oceanographic Institution, November 16-18, 2011. The workshop was used to assess the state of scientific understanding on the Bay of Bengal. There were 41 participants at the workshop, 6 of which were invited scientists from India. A summary report that identified key questions of interest was put together after the workshop. Understanding intra-seasonal monsoonal variability and the underlying oceanic processes was identified as the challenge to be addressed through further study. The workshop was successful in laying the foundation for developing international collaboration.

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Bay of Bengal, Indian Monsoon, intra-seasonal monsoonal variability.

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LONG-TERM GOALS

Our long term aim was to begin an international collaboration for studying the Northern Indian Ocean (Bay of Bengal). This region of the ocean plays a strong role in the Monsoons through air-sea interaction. The predicatability of medium to long-range weather forecasts remains poor in this region. Our interest is to understand the ocean's role in monsoonal variability and in the sensitivity of monsoonal forecast models.

OBJECTIVES

The objectives of this project were to make a community-wide assessment of the state of scientific understanding on the role of the Bay of Bengal in the Indian Monsoon and to identify the most important processes and factors concerning the predictability of monsoonal processes. A secondary objective was to begin a scientific dialogue with colleagues in neighboring regions, primarily India and Sri Lanka.

APPROACH

Our approach was to convene an international scientific workshop that brought together experts from the community, and from India, to present recent research findings and hold discussions to identify questions of interest in the region. We would form a "state-of-the-science" summary, list of relevant questions, and define the next steps for studying this region.

TASKS COMPLETED

An international workshop titled, **Role of the Bay of Bengal for Prediction of the Indian Monsoon** was held at the Woods Hole Oceanographic Institution on November 16-18, 2011.

To organize this workshop, we targeted scientists whose research is pertinent to the oceans and Monsoons and invited them to participate and define the topics for the workshop. We also identified and invited six scientists from various institutions within India. They were M. Ravichandran, Debasis Sengupta, Suryachandra Rao, Rashmi Sharma, R. Venkatesan and V.S.N. Murty. An agenda was developed, and travel and logistic arrangements were made for hosting the scientists from abroad. The organization and coordination of the meeting was carried out with the help of WHOI's administrative staff.

There were 41 participants in attendance. The talks and discussions addressed 5 topics: (i) Bay of Bengal and the Monsoons: Circulation, upper ocean structure and dynamics, (ii) Upper ocean mixing and stratification / effect on Air-sea heat and moisture fluxes, (iii) Intra-seasonal variability (days to weeks) and predictability, (iv) Observational inferences and advances, and (v) Monsoon modeling - ocean/ atmosphere coupled, process modeling, LES.

We used the input of the workshop participants to write a whitepaper describing the state of scientific understanding. This report was sent to ONR Program Managers Scott Harper and Terri Paluskiewicz.

RESULTS

Predicting intra-seasonal monsoonal variability, and active and break periods is one of the major challenges that faces the modeling community. It is related to anomalies in sea surface temperature (SST) that propagate northward in the Bay. The SST responds to the upper ocean vertical density structure set by freshwater input, heating, lateral advection and vertical mixing. We identified 3 major areas of focus: Sea surface temperature (SST), freshwater, and momentum, along with the processes that affect these properties and their transfer.

While the large-scale Bay of Bengal (BoB) circulation is well understood by models and observations, the diel to sub-seasonal variability is not. The following questions present a cross-section of questions that arose during the workshop.

What sets the SST structure in BoB over intra-seasonal time scales? What is the freshwater distribution and budget in BoB at intra-seasonal time scales? What controls the speed and intensity of the northward propagating intra-seasonal oscillations? Does SST distribution determine how far north monsoon intra-seasonal-oscillations can penetrate? What are the possible mechanisms for the coupled intra-seasonal variability? What is their predictability on daily to intra-seasonal time scales?

Does the formation of barrier layer in BoB occur due to mixing and slumping events or fanning out of the river freshwater in the BoB? How does the barrier layer affect the SST

and the air-sea fluxes at the sub-seasonal scale? To what extent does the systematic presence of a barrier layer in the BoB alter atmosphere-ocean feedbacks?

What processes control offshore export of riverine input? What governs exchange across the shelf-slope system?

What role do Ekman dynamics play in governing lateral advection and vertical exchange?

What is the relationship of eddies in the western BoB to the Western Boundary Current?

Does higher SST, or perhaps heat content locally increase atmospheric convection, cloudiness and rain in the BoB? What is the relationship between cloudiness and net air-sea heat flux in BoB? How can models and products be modified to better capture this relationship?

What processes govern the formation of the barrier layer vertical structure and, in particular, the stratification in upper-ocean salinity and the lack of stratification in temperature?

IMPACT FOR SCIENCE

The workshop was successful in laying the foundation, both scientifically and in opening communication, for developing an international collaborative study of the Bay of Bengal. A follow on workshop was hosted by our Indian colleages at the Indian Institute of Science in Bangalore, in March 2012, who which 12 U.S. scientists were invited. This helped the Indian scientists (lead PI Debasis Sengupta) to develop a proposal to the Ministry of Earth Sciences in India for conducting an obesrvational program in the Bay of Bengal in collaboration with U.S. scientists. A group of six U.S. scientists, including ONR program managers, was invited to the foreign consultancy meeting of Indian's National Monsoon Mission held in Pune in September 2012. Consequently, the U.S. scientists gathered in April 2013 to discuss DRI plans for the field program in the Bay of Bengal beginning in November 2013 and the Indian proposal has been approved within India.

RELATIONSHIPS TO OTHER PROGRAMS

The DRI program ASIRI is now underway for studying the Bay of Bengal. Studies are being conducted in collaboration with Sri Lanka and India. The Indian program Ocean Monsoons and Mixing (OMM) took root at the workshop described above.
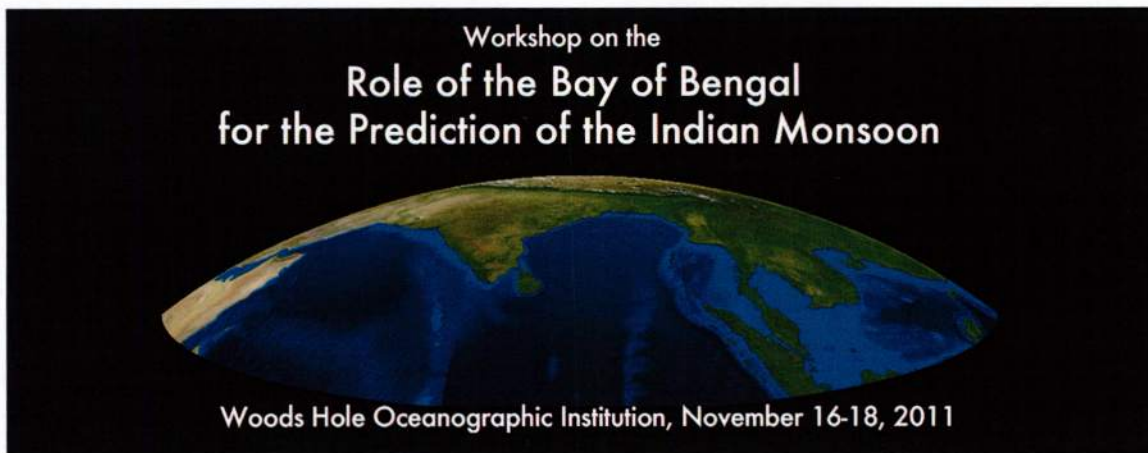
Figure 1: Workshop banner.

Figure 2: Group photograph of participants at the workshop in November 2011.